MULTI-POINT SEAT BELT

CROSS REFERENCE TO RELATED APPLICATIONS

This is a divisional ~~continuation-in-part~~ application of the US-serial number 09/554,463 related to an international application number PCT/DE98/03270 (WO 99/24294, European Patent EP 1 037 773 B1, German Patent DE 197 49 780 C2) filed Nov. 10, 1998.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

It is an object of the present invention to adapt a belt-feeding device to the seat-design and, while preserving user-friendliness, to ensure the restraint of every passenger of a transport system and to lower all acceleration-dependent forces imposed on them in order to enhance the survival chance in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) or during in-flight turbulence.

~~It is an object of the present invention to ensure the restraint of a passenger in order to enhance the survival chance associated with lowering all acceleration-dependant forces in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) of a transport system (a motor vehicle, a train or an aeroplane) or during turbulence-related vibrations of an aeroplane.~~

2. Discussion of the Prior Art:

It is known in the prior art to provide for a passenger of a transport system

- a three-point seat belt (safety belt or lap-shoulder seat belt assembly), mounted in the motor vehicle, consisting of a shoulder belt extending across the upper body-part of his body and of a lap belt extending across the lower body-part of his body; or
- a two-point seat belt, mounted in the aeroplane, acting as a lap belt extending across the lower body-part of his body; or
- a suspender- (waist-) belt consisting of several pieces (belt-members).

In order to formulate in single terminology a generalized definition is presented for the proper term:

Definition:	**Proper Term:**
"Transport system"	Motor vehicle or train or ship or aeroplane
"Stiff first transport-system member"	Floor **6** of the transport system adjacent to a first seat-side SR (**Fig.** 1) or seat-cushion frame at the first seat-side or mid-tunnel (not drawn) of the motor vehicle adjacent to the first seat-side.
"Stiff second transport-system member"	Floor **6** of the transport system adjacent to a second seat-side SL or seat-cushion frame at the second seat-side or post section **91** (**Fig.** 13) of the motor vehicle adjacent to the second seat-side or side rail of the motor vehicle adjacent to the second seat-side
"Stiff third transport-system member"	Floor **6** of the transport system adjacent to the first seat-side or seat-backrest frame of the seat at the first seat-side.
"Stiff fourth transport-system member"	Floor **6** of the transport system adjacent to the second seat-side or seat-backrest frame at the second seat-side or post section adjacent to the second seat-side.
"Shoulder-belt deflector"	Belt deflector **5**, **5b** or D-ring **12** (**Fig.** 1)

It is well known to provide different restraint systems in vehicles, predominantly, three-point seat belts in various types for seats~~, exemplified by DE 37 41 831 A1 shown in **Fig.** 11~~. Evidently, when both shoulders of a passenger, conventionally belted, are not restrained in the event of an arbitrary collision with another vehicle in any direction, shown in **Figs.** 3, 4 and 7, the unrestrained shoulder can always move and/or rotate freely, thereby resulting in severe/fatal injuries in real-world accidents when

- the head crashes into the steering wheel and/or window pane and/or
- the airbag crushes the head, which, loaded by the forces related to pitch-acceleration $\ddot{U}_H$, yaw-acceleration Ö, longitudinal and/or lateral acceleration, is in "oop" (out of position).

Moreover, by the definition of „submarining" the belted passenger submarines (slips downward) under his seat belt thus negating the protective effect of the seat belt.

It is well known to provide two-point or lap seat belts for aeroplane seats as well as mid-portion of the rear seats of motor vehicles. This lap seat belt is far less effective than a three-point seat belt. Due to very large accelerations during a turbulence-related flight the protective effect is very low.

A substantially improved protection is proposed by two different configurations of a one-piece seat belt, exemplified by DE 26 02 875 A1 (**Figs.** 8 to 10). An „X-shaped" restraint is arranged by extending both shoulder belts crosswise over the upper body-part of body while the lower body-part of body is restrained by the lap belt. Each end of the one-piece seat belt is connected to a belt retractor, fastened in the seat backrest. Two grab rings, positioned to the headrest, move along the belt. A single or double „X-shaped" configuration is defined by pulling a pair of grab rings and belt portions over the head, shoulders and head rest and engaging them in the corresponding hooks. Due to such intricate operation the seat belt remains unused.

According to US 3,977,696, US 5,123,673, US 5,411,319, DE-OS 23 45 847, DE-OS 28 13 888 and DE 196 29 878 A1 the restraint system comprises a three-point seat belt, a second shoulder belt and two belt retractors, responsible for retracting both belts. The „X-shaped" configuration, formed by extending both belts crosswise over the upper body-part of the body, has the following drawbacks in the event of an accident:

D1. Both belts are retracted to different length by two independently operating belt retractors within milliseconds.

D2. Under the load of the same belt force in a front collision the deformation of seat backrest, wherein both belt ends are fastened, is larger, thus increasing the forward motion. Furthermore, it is impossible to attach an energy absorber because all four belt ends are occupied.

D3. Exemplified in US 5,123,673, the belt user has to depress two release buttons to release the respective main latch plates **9** from the main buckle assemblies. This two-click operation causes discomfort and hinders rescue work. See countermeasures by means of a single master release button, mentioned below.

A one-piece seat belt **1** (**Fig.** 1) ref. to DE-OS 28 13 888 is equipped with two belt retractors (not drawn), fastened to both belt ends in the seat backrest, and a belt deflector **17**, anchored to the seat-cushion frame **3.3** of the mid-portion of rear seat. The feature, proposed for a child, has the following drawbacks:

D~~3~~4. When the release button **84** is depressed, the first shoulder belt portion **1.1** gets entangled around the neck of passenger. For the operation of restraining and extending both belt portions into the „X-shaped" configuration, the passenger must lower his head first.

D~~4~~5. Because all belt ends are occupied, it is impossible to attach energy absorbers and to adjust the belt to the size of an upper body-part of body **95** of an adult.

Generally, a child-seat is fastened by four auxiliary belts to the seat. Despite the „X-shaped" configuration of a one-piece seat belt to restrain a child, sitting in a child-seat, ref. to FR 2 342 872 A1 the problems, associated with the retraction of four auxiliary belts, submarining and energy absorption, remain unsolved in an accident.

Till now, trains, school buses and buses are not provided with restraint systems.

SUMMARY OF THE INVENTION

Accordingly, the principle object of the present invention is to provide for passengers of a transport system seat belts, each equipped with a belt retractor, solely responsible for retraction, blocking and tightening or for protraction, a lower belt deflector to loosely guide a belt portion and multi-attachment points (multi-points of restraint), and to restrains ~~a~~ every passenger in multi-attachment points, in order to lower and distribute the acceleration-dependent loads, shown in **Fig.** 3 and **Tables** 1 to 3, to the multi-attachment points in the event of any accident ~~thereof~~ or during in-flight turbulence~~-related vibrations of an aeroplane~~. Nowadays, belt tighteners are incorporated into belt retractors, for example, of MB 500 SL in order to save costs, assembly time and space.

A second object of the present invention resides in an integration of a belt-feeding device in a seat, shown in **Figs.** 12a to 12f, in a user-friendly belt-feeding device to ease the restraint and serve as a protective-rollover device, shown in **Fig.** 17, as well as in comfort enhanced by one-click operation by means of a single master release button, which, when depressed, ~~to~~ releases all latch plates from the buckle assemblies and/or returns the belt-feeding device to the home (resting) position. In emergency cases paramedics and fire-fighters can easily rescue the injured passengers.

A third object of the present invention resides in the conventional three-point seat belt associated with new parts, shown in **Fig.** 2, to serve as a transition product until multi-point seat belts are put into production.~~cost-, space-saving integration of the multi-point seat belt,~~

~~equipped with energy-absorbers, and the seat into a baby-cot, child-seat or safety seat, illustrated in Figs. 1, 23.~~

INDUSTRIAL APPLICABILITY

It should be apparent that the invention provides ~~a~~ substantially improved restraint, including the following features:

a) The survival chance is enhanced by the restraint of
   * both shoulders and the torso, when the passenger is thrown forward (**Fig.** 4, **Table** 3) and/or subjected to the yaw Ö-acceleration-dependent torque $T_{\ddot{o}}$, and
   * both thighs and the lower body-part of the body to prevent ~~, when the passenger~~ submarinesing (**Figs.** 14, 15).

b) Because the belt retractor is attached to one belt end, a number of sets of vibration-dampening energy absorbers ref. to US serial no. 09/554,464 (WO 99/24292, ~~(~~PCT/DE98/03271, European Patent EP 1 037 771 B1, German Patent DE 197 58 498 C2, CA pending ~~US and CA~~ patent 2,314,345) or German Patent DE 197 58 497 C2 can be attached to the other belt end (**Figs.** 11~~2~~a to~~,~~ 11~~2~~bc~~,~~ ~~18~~), thus gradually absorbing large impact energy below the respective injury-related values. The inventor of the present application has submitted those patent documents and applications to CIPO as well as USPTO. The vibration-dampening energy absorber consists of a number of clamping elements, having sites of predetermined fracture, and a retaining element, which, fastened to the seat-backrest frame and/or seat-cushion frame, can serve as an integral part thereof.

c) Owing to the different positions of pairs of upper buckle assemblies, in plug-in connection with the respective belt-detachable latch plates **25** (**Fig.** 16~~7~~), passengers of different body proportions can adjust the belts by themselves. Moreover, the seats, equipped therewith, can be modified to be used by adults or children, thus increasing the rate of seat occupancy in a bus, train or an aeroplane, exemplified in **Fig.** ~~23~~15.

~~b) In another embodiment an upper belt deflecor **5b** (**Fig.** 15), in plug-in connection with the buckle assembly **4**, or the buckle assembly **4** is height-adjustable. Energy absorbers, above-mentioned, can be connected to this buckle assembly. Upon the use of the height-adjustable belt deflector **5b** the height-adjustable D-ring **12**, attached to the B-, C-, D-post section (pillar, pillar portion), shown in **Fig.** 1, or to the top edge of the seat backrest, is no longer needed. When the belt deflector **5b** is not height-adjustable, it can be connected to energy-~~

~~absorbers which absorb energy and dampen vibration when the first shoulder belt portion moves it up.~~

~~c) In another embodiment the upper belt deflector 5a (Fig. 13) can be rigidly attached to the head rest 3.6a. Any adjustment of the height of the head rest 3.6a to the head automatically adjusts the height of the upper belt deflector to the shoulder. This feature differs from the D-ring ref. to DE 40 10 452 A1, which is in contact with the shoulder belt, when the passenger is thrown forward, and is moved up to intercept the head, when thrown backward.~~

~~g)~~d) In resting position the shoulder latch plate **2**, in plug-in connection with an assisting buckle assembly **16, 16a, 16b,** fastened to the seat cushion **3.1**, B-, C-post section or seat backrest (**Figs.** 1, 2), is easily accessed by the passenger ~~having the intention~~ wanting to use the belt.

~~h)~~e) The seat belt can be equipped with a belt-feeding device, manually operated or by a drive apparatus, for example, hydraulic-piston cylinder unit, electrical motor (not drawn), which enhances the convenience and comfort of the user. This drive apparatus is switched on by a pressure sensor, built to the seat, or an existing switch such as lighting-, door- or touching switch. If the belt is not engaged within a dwell time, a control device is activated to switch off the drive apparatus and to reposition the belt-feeding device in the resting position.

~~i)~~f) For the convenience of the passenger, when stepping out, or <u>for</u> the quick-rescue of the <u>injured</u> passenger~~, when being rescued~~ in accidents, the master release button **84** of the buckle assembly **9.1** is depressed to release all latch plates from the buckle assemblies and/or to return the belt-feeding device to the resting (home) position.

~~j)~~g) The round rollover tubes **20.2b** of the seat backrest frame **3.4d** are designed to guide the belt housing **20.4c, 20.4d** (**Figs.** ~~18, 19~~<u>16, 17</u>), to act as safety bars in a rollover and to allow free view to the rear owing to openings **97R, 97L** (**Fig.** ~~23~~<u>15</u>).

~~In another embodiment the seat belt can be connected to the seat in more than three attachment points (Figs. 1, 14, 23), in which both thighs (femurs) are restrained, thus protecting the passenger from submarining in a front, rear collision or rollover or when in sleeping position. Unlike the suspender (waist) belt, consisting of several belts, the portions of multi-point seat belt need not be adjusted in length, when the circumference of the passenger varies depending on the clothes worn.~~

BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments, other advantages and features of the present invention will be described in the accompanying tables and drawings with reference to the xyz global coordinate system:

Table 1 shows test data such as left / right thigh-force, belt force and pitch-angle of driver and co-driver in 50% offset crash test of several European vehicles at crash speed of 55 km/h.

Table 2 shows yaw angle O of driver / co-driver in a 50% offset crash tests.

Table 3 shows test data of the safest child-restraint system Chico Shuttle® at the converted velocity of 55 km/h in comparison with the safest vehicle among them listed in **Table** 1.

Fig. 1 is a perspective view of a seat with buckle assemblies attached to the seat backrest and seat cushion as well as of ~~the~~ a 1st embodiment of a restraint system consisting of a multi-point seat belt **1**, shoulder-belt deflector **5**, D-ring **12**, latch plate **11** ~~movable~~ moveable along the lap belt, shoulder latch plate **2** of belt end portion, in the direction of arrow „Z" in plug-in connection with an upper buckle assembly **4**, and a seat belt in X-shape, formed by crossing ~~both~~ the first and second shoulder belt portions **1.1, 1.2**.

Fig. 2 is a perspective view of a seat and of ~~the~~a 2nd embodiment of a restraint system comprising three-point seat belt **1e** having a transition latch plate **2**, which will be inserted into a transition buckle assembly **4e** of a shoulder belt **1.11**, pulled in the direction of arrow „Z".

Fig. 3 illustrates load cases I, II and III in z-y plane in the event of a real-world accident.

Fig. 4 is a perspective view of a restrained dummy thrown forward in VW Polo® in a 50% offset crash test.

Fig. 5 illustrates a yaw-acceleration Ö and yaw-angle O of a vehicle about the vertical axis „z_A" in a 50% offset crash test of two identical vehicles.

Fig. 6 illustrates a yaw angle O of vehicle about the vertical axis „z_A" in a 50% offset crash test into a stiff barrier.

Fig. 7 illustrates four collision types „U1" to „U4" ref. to the research work of Institute of Vehicle Safety, a Dept. of German Insurers Association.

Fig. 8 is a front view of a seat belt ref. to DE-OS 26 02 875 in the home position.

Fig. 9 is a front view of a double X-shaped seat belt ref. to DE-OS 26 02 875.

Fig. 10 is a front view of a single X-shaped seat belt ref. to DE-OS 26 02 875.

~~Fig. 11 is a top view of a ∠-shaped seat belt ref. to DE 37 41 831 A1.~~

Fig. 1~~2~~1a is a schematic, perspective view of ~~the~~a 1st embodiment of a buckle assembly **4a**, equipped with release cable **4.2**.

Fig. 11~~2~~b is a schematic, perspective view of a~~the~~ 2nd embodiment of a buckle assembly **4b**, equipped with an electrical release-motor **4.2b**.

Fig. 11c is a schematic, perspective view of a 3rd embodiment of a buckle assembly **4c**, equipped with a release cable **4.3**.

~~**Fig.** 13 is a perspective view of an upper belt deflector of the head rest.~~

Figs. ~~17a~~ 12a to ~~17f~~ 12f are schematic, perspective views of a 1st embodiment of ~~the~~ a belt-feeding device **20** in kinematics from the resting position to the operati~~n~~gve position.

~~**Fig.** 13 is a perspective view of an upper belt deflector of the head rest.~~ **Fig.** 16~~3~~ is a schematic view of ~~the~~a 2nd and 3rd embodiment of spatially-adjusting belt-feeding devices **20a** and **20b** in kinematics from the operati~~n~~gve position to the resting position in x-y plane.

Fig. 14 is a perspective view of ~~a latch plate **11** of a lap belt portion **1.3** in plug-in connection with a buckle assembly **8** and of~~ the 1st embodiment of a~~the~~ belt-feeding device **20** of the seat belt.

Fig. ~~23~~15 is a front view of the seat **3a to 3d**, in which the restraint systems **1a to 1d** are integrated, for passengers of different weights and body proportions (sizes).

~~**Fig.** 15 is a perspective view of the 2nd embodiment of a spatially-adjusting belt-feeding device **20a** from the resting position to the operating position and of a height-adjustable belt deflector **5b**.~~

Fig. ~~18~~16 is a schematic, perspective view of a seat, equipped with ~~the~~ rollover tubes **20.2b**, and of ~~the~~a 4th embodiment of a belt-feeding device **20c**.

Fig. ~~19~~17 is a schematic, perspective view of a seat having ~~the~~ rollover tubes **20.2b**, ~~the~~a 5th embodiment of a belt-feeding device **20d**, provided with a safety bracket **20.6**, a height- and width-adjusting mechanism **27, 27a**.

~~**Fig.** 20 is a cross-sectional view of the 1st embodiment of the height- and width-adjusting mechanism **27** along the line I-I of **Fig.** 19.~~

~~**Fig.** 21 is a cross-sectional view of the height- and width-adjusting mechanism **27** along the line II-II of **Fig.** 20.~~

~~Fig. 22 cross-sectional view of the 2nd embodiment of the height- and width-adjusting mechanism 27a along the line I-I of Fig. 19.~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The advantages of the preferred embodiments in the Chap. "INDUSTRIAL APPLICABILITY" are outlined hereinafter with regard to the functions and features thereof.

The method of the present invention capitalizes on the premise that a seat belt is employed to restrain a passenger in at least four attachment points of the seat to distribute all acceleration dependant loads, particularly the yaw Ö-acceleration-dependent torque $T_ö$, thereto in an accident, thus ensuring the operation of a single belt retractor to pre-tension (bias) as well as tension the belt, restraining both shoulders, upper- and lower body-part of the body and lowering all the loads, in particular, in co-operation with the energy-absorption when a number of sets of vibration-dampening energy absorbers is put into use. This will be apparent when all forces, imposed on the belted passenger, shown in **Figs.** 3 and 4, are formulated in the event of a front collision, where the loads of the mass D_S of the torso are lowered because

- the forward motion „w_v" is minimized, thus substantially reducing the pitch-acceleration $Ü_H$ and force F_{Hy} of the mass D_H of the head, and
- the yaw-acceleration Ö is minimized, thus substantially reducing the torque $T_ö$, imposed on the head. Great torque $T_ö$ is the most latent force, responsible for sudden death.

To a great extent massive head injuries can be avoided.

Load case I in z-y plane: The rotating mass D_S rotates about the rotating axis „S" at the pitch-angle U_S and mass D_H about the rotating axis „z" at the pitch-angle U_H in **Table** 1, thereby resulting in the pitch-accelerations $Ü_S$, $Ü_H$ and rotating forces F_{Sy}, F_{Hy}. The addition of both rotating forces yields the force F_V linked to the forward motion w_V of passenger, shown in **Fig.** 4.

~~In front- and/or rear-collision the passenger is exposed to the submarining force S_y, shown in Fig. 14.~~

Load case II in x-y plane: The upper body-part of body is subjected to the torque $T_{\ddot{o}}$, exerted by the yaw-acceleration Ö about the rotating axis „z". When the upper body-part is restrained in an X-shape, the torque is substituted by a pair of forces.

Load case III in x-z plane: The rotating mass D_S rotates about the rotating axis „S" at the rotating angle U_y and mass D_H about the rotating axis „z" at the rotating angle U_{Hy}, thereby resulting in the rotating accelerations $\ddot{U}_y$, $\ddot{U}_{Hy}$ and rotating forces D_{Sy}, D_{Hy} (not drawn). In a rollover-accident the passenger is subjected to the load F_{Sz}.

Load case IV: In turbulence-related vibrations of an aeroplane the load D_{Sy} together with D_{Hy} takes the form of periodical load $\pm F_{Hx}$, F_{Sz} of $\pm F_{Sz}$, $T_{\ddot{o}}$ of $\pm T_{\ddot{o}}$, S_y of $\pm S_y$ and F_{Sy} together with F_{Hy} of $\pm F_V$.

The restraint system, illustrated in **Fig.** 1, is provided with a conventional belt retractor **13** having a clamping device, housed in the B-, C-, D-post section or in the seat backrest **3.2** at one of both seat-sides SL and SR of a seat ~~backrest **3.2**~~ and connected to the second belt end EL. The ~~other~~ first belt end ER is provided with a shoulder latch plate **2**, which is retained, loosely guided by a lower belt deflector **17**, fastened to the vehicle floor, and inserted into one of the upper buckle assemblies **4, 4a to 4c, 14, 14a, 18, 18a, 18b**, arranged in or to the seat backrest **3.2**. In all embodiments ~~an additional~~ main latch plate **9** can move along the seat belt **1** between both belt ends EL and ER. When plug-in connecting the shoulder latch plate **2** (in the direction of arrow "Z") to the buckle assembly **4** and the main latch plate **9** to the main buckle assembly **9.1**, an X-shaped restraint of the upper body-part of body and both shoulders as well as a restraint of the lower body-part of body are accomplished by the ~~both~~ first and second shoulder belt portions **1.1, 1.2** and the lap belt portion **1.3**.

In the 2nd embodiment, shown in **Fig.** 2, a transition product, comprising a conventional three-point seat belt **1e** and new parts, has to be invented due to the delay in producing ~~resulting from the production of~~ multi-point seat belts **1**. The floor fitting (not shown) is replaced by the lower belt deflector **17**. The first belt end of the lower first shoulder belt portion **1.11** is provided with transition latch plate **2**. The first belt end of an upper first shoulder belt **1.12** and the ~~other~~ second belt end are equipped with a transition buckle assembly **4e**, having a transition release button **84c**, and with a second belt retractor **13a**, arranged in the seat backrest **3.2**. Due to the second belt retractor the transition buckle

assembly **4e**, acting as the shoulder latch plate **2, 2a** of multi-point seat belt, is located in a home position on a seat-backrest aperture of the seat at the first seat-side. Hence, the seat-design is not compromised. In a coupling position t~~T~~he restraint in an X-shape is defined by plug-in connection of transition latch plate **2** with the transition buckle assembly **4e**, pulled out from the seat-backrest aperture, wherethrough a transition portion of the upper first shoulder belt is projected. This transition portion and the lower first shoulder belt portion **1.11** define the first shoulder belt portion **1.1**. In order to resolve the above-mentioned drawback **D1**, the spring force of the second belt retractor **13a**, to retract the upper first shoulder belt **1.12**, released by ~~on~~-depressing the transition release button **84c**, is far less than that of the belt retractor **13**. Although ~~Despite~~ the circumference of the restrained passenger varies, ~~varying~~ depending on the clothes worn, and the seating-position differs ~~different seat position~~ the lower first shoulder belt portion **1.11** always projects through the lower belt deflector **17** at a sufficient length of "l_1" ~~in order~~ to maintain the function of the belt retractor **13** to retract, to block the belt as well as to release the retracted belt during the journey ~~travel~~ and the function of the belt tightener (not drawn), incorporated in the belt retractor, to forcefully retract (withdraw) and tighten the belt in an accident. The transition release button **84c** of transition buckle assembly **4e**, arranged to or in the seat, can be controlled neither by release cable **4.2** nor by electrical release-motor **4.2b**. ~~Hence, the release button 84c~~ It can only be activated by electrical signals emitted from the master release button **84** when depress~~inged the master release button 84~~.

The ~~other~~ second belt end of upper first shoulder belt **1.12** can be connected either to a coupling fitting **1.2a, 1.2b, 1.2c** (**Figs.** 1~~12a~~, to 1~~12c, 18, 19~~) or to the second belt retractor **13a** (~~belt retractor 13 shown in Fig. 18~~)having a coupling fitting **1.2b** (**Fig.** 1~~5~~6) in order to receive a number of vibration-dampening energy absorbers to dissipate great impact energy and dampen strong vibration.

In another embodiment ~~the~~an upper first shoulder belt **1.12a** consists of the transition buckle assembly **4e** and a shoulder latch plate **2a** (not shown), similar to latch plate **2** (**Fig. 1**), which is plug-in connected to

- the upper buckle assembly **4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3**, arranged ~~in~~ to the seat backrest, in operati~~o~~nve position or
- the assisting buckle assembly **16, 16a, 16b** in resting position.

When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, ~~of~~ the lower

belt deflector **17**, ~~of~~ the second belt retractor **13a** and by a variety of one-piece, detachable, upper first shoulder belts **1.12a** with different lengths. Furthermore, the latch plate **2a** can be detached from the buckle assembly by depressing the master release button **84**.

A first shoulder belt portion **1.1** is defined by the upper first shoulder belt ~~**1.12,**~~**1.12a** and the lower first shoulder belt portion **1.11**.

~~At~~ With an expensive modification or ~~at~~ in new transport system the convenience and comfort are enhanced by the use of belt-feeding device **20, 20a to 20d** ~~enhances the convenience and comfort~~, where the upper first shoulder belt **1.12, 1.12a** ~~having~~ with transition buckle assembly **4e** is a part ~~there~~of the belt-feeding device.

~~Evidently~~Beyond doubt, the three-point seat belt **1e** in plug-in connection with the upper first shoulder belt **1.12, 1.12a** ~~serve~~is suited as a temporary ~~transition~~ solution for the multi-point seat belt **1, 1a to 1d** ~~during the production~~.

In the above-mentioned embodiments to resolve the above-mentioned drawback **D3**~~**3**~~**4** the upper body-part of body is restrained by extending the shoulder belt portions crosswise in an X-shape when the belt-feeding device **20, 20c, 20d** positions the first shoulder belt portion **1.1**, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operative position to a resting position. Theise features ~~c2) and c3)~~ haves the advantage that the common practise to operate the conventional three-point seat belt is preserved.

~~c1) when at least one latch plate **2** is plug-in connected to the buckle assembly of the seat backrest; *or*~~

~~c2) when a latch plate **2**, arranged to the end ER of the first shoulder belt portion **1.1** of a belt-feeding device **20a, 20b**, is plug-in connected to the buckle assembly of the seat backrest; *or*~~

~~c3) when the belt-feeding device **20, 20c, 20d** positions the first shoulder belt portion **1.1**, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operation position to a resting position.~~

~~These features c2) and c3) have the advantage that the common practise to operate the conventional three-point seat belt is preserved.~~

In order to resolve the above-mentioned drawbacks **D2** and **D4**~~**4**~~**5** great energy is absorbed and strong vibration is dampened by a large number of vibration-dampening energy absorbers connected to the respective upper buckle assemblies **4, 4a to 4c, 4e, 7, 8, 8a to 8d, 9.1, 14,**

14a, 15, 15a, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3 (**Figs.** 1, 15~~4, 19, 23~~) ~~in~~to which latch plates are ~~inserted~~plug-in connected.

~~As shown in **Figs.** 1 and 14, the seat belt **1** is equipped with an anti-submarining latch plate **11**, which can be connected to one of the buckle assemblies **7, 8, 8a to 8d**, arranged in or to the seat frame **3.3**. When plug-in connected, the lap belt portion **1.3** is subdivided into two belt portions **1.3R, 1.3L**. Owing to the restraint of both thighs the submarining problem in front- or rear collision, in rollover or turbulence-related vibration of an aeroplane is resolved. Moreover, the passenger, lying in a sleeping position, is well protected.~~

~~Because the reel (spool) of the conventional belt retractor can accommodate only a limited length of belt, it is possible that the length of the seat belt for the sleeping position is insufficient. As exemplified in **Fig.** 1, a buckle assembly **8b, 8c** is provided with a release button **84c** and a length-adjustable belt, fastened to the seat frame, for the purpose of compensating the length of seat belt **1** between the sleeping and normal position.~~

~~A buckle assembly **8d**, provided with a release button **84d**, is attached to the front portion of the seat cushion.~~

~~Owing to the plug-in connection of the anti-submarining latch plate **11, 25** with one of the buckle assemblies a lady in a long gown as well as a child are well protected from submarining (**Fig.** 23).~~

The lower belt deflector **17** comprises a housing having an attachment hole to receive a pin **17.1**. Both members can be made in one piece. If necessary, the pin **17.1** is surrounded by a sleeve **17.2** of plastics, having corrugation or knobs, which is a common part of the conventional D-ring **12**. This D-ring **12** can be replaced by the lower belt deflector **17**. The aperture of the belt deflector **17** to loosely guide the belt portion is dimensioned so as ~~to such a size~~ to retain the latch plate **2** in resting position, thus allowing the use as a three-point seat belt.

In the 1st embodiment ref. to **Figs.** 14, 1~~7~~2a, 1~~7~~2d the belt-feeding device **20** in resting position is provided with a device to countersink the belt-feeding plate **20.9** in the seat backrest to improve the overall impression of the seat-design, whereon the sales success depends.

When the passenger takes his seat, a drive apparatus, being activated,

- moves up over the head rest a contact portion of the belt-feeding plate **20.9**, moveable in an opening of the seat backrest (**Fig.** 172a), out of the opening and then the guide tube **20.1** with the operating arm **20.2**, whose belt ring **20.8** houses and loosely guides the first belt portion **1.1** (**Fig.** 172b);
- rotates the operating arm and the first shoulder belt portion over the head rest, his head and in front of the upper part of his body **95** at „β" (**Fig.** 14), where in a contact position a key of the operating arm projects through a receptacle of the contact portion of the belt-feeding plate **20.9** or a clamping receptacle **20.11** of the belt-feeding plate **20.9a** (**Figs.** 172c, e, f); and
- countersinks the contact portion of the belt-feeding plate **20.9** or **20.9a** and the guide tube **20.1** with the operating arm **20.2** until reaching the ~~operating~~ operative position in which the first shoulder belt portion extends across over the upper part of his body and the drive apparatus is switched off (**Fig.** 172d).

To prevent the entanglement of the first shoulder belt portion **1.1** behind the seat, particularly when positioned furthest forward, that first shoulder belt portion **1.1** in resting position is intercepted by the belt-catching member **20.7, 20.7a** (**Figs.** 14, 172a, 172b). When the second shoulder belt portion **1.2** and the extending belt portion **1.4** are arranged to the post section, both shoulder belt portions can also be intercepted by the belt-catching member.

When the seat **3c** (**Fig.** ~~23~~15) has a high seat backrest, the curved guide tube **20.1** of belt-feeding devices **20ax** (~~**Fig.** 15~~not drawn) can be modified ~~in~~ to a straight-running operating arm **20.2** of the belt-feeding device **20** (**Figs.** 12a to 12f).

~~In the 2nd or 3rd embodiment the belt feeding device **20a or 20b** is provided with a height-adjustable belt housing **20.4a** and radial-adjustable tube **20.3** (**Figs.** 15, 16). Both devices differ from each other by the position of the guide tubes **20.1** on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube **20.1** of the belt feeding device **20a** is pivotally attached in a stiff supporting tube **3.61** of the height-adjustable head rest **3.6a**.~~

~~The height of „Δh" of belt housing **20.4a**, having a latch plate **2**, plug-in connected to any buckle assembly **4, 14, 18**, is adjustable when the passenger moves two openings, facing each other, along the operating arm **20.2a**. Alternatively, the passenger can move a handle **5.2**, such~~

~~as locking handle 27.5 of the height- and width-adjusting mechanism 27, 27a (Figs. 15, 19 to 22), to adjust the height of „Δh" of upper belt deflector 5b.~~

In order to ensure the operation of pro- and retracting any shoulder-belt portion, arranged in the seat backrest (**Figs.** 8 to 10), is loosely guided by a shoulder-belt-deflector which, having a rectangular shape, is usually pressed in a seat-backrest aperture of the seat backrest on the top edge.

The belt-feeding devices **20a, 20b** have to meet the following criteria:

- Passengers can freely get in and out of the vehicle compartment thanks to the distances of „a" and „b" between the post section **91** and operating arm **20.2a** (**Fig.** 163) in resting position; and
- the device, when moved, does not~~doesn't~~ interfere with the head rest **3.6a**, height-adjustable about „Δh_K", and with the head of the passenger with/without hat **92**.

Regarding the kinematics of the height-adjustable belt housing **20.4a** with the latch plate **2** from the ~~operating~~ operative position to the resting position, the trajectories of „Ba2" and „Bb" are well clear of the passenger's head ~~not in the range of a hat~~ thanks to a radial-adjustable tube **20.3** incorporated into the operating arm **20.2a**. Without the radial-adjustable tube **20.3** the operating arm in the trajectory of „Ba1" would interferes with that hat.

In the 4th and 5th embodiment ref. to **Figs.** 186, 197 the belt-feeding devices **20c, 20d** differ from each other by the rotatory movement of the operating arm **20.2**, whose guide tube **20.1** is pivotally attached to a bearing casing **20.10**. Preferably, upon the rotation about the head, the translatory and rotatory movement of belt are synchronised.

To form the upper part of the seat backrest frame **3.4d** a pair of angle fittings **26a**, a pair of rollover tubes **20.2b** and a pair of side girders **27.1a** or four tubes **27.1** (not drawn) are form- and/or force-locking connected to each other by connecting pins **26.2**, **26.3** (drawn with dotted lines) and/or by welding, bolting, ~~glueing~~gluing and/or riveting. The belt housing **20.4c** or **20.4d**, having a moveable safety bracket **20.6**, is guided by rollover tubes **20.2b** and driven by an electrical motor **20.5** along the threaded spindle **20.1a**, fastened to both angle fittings **26a**, from the resting position (drawn with dotted lines) to the ~~operating~~ operative position, and back again. In the ~~operating~~ operative position the holes of the rollover tube **20.2b** and belt housing **20.4d** are aligned with each other, thus permitting the legs of the safety bracket

20.6, loaded in the event of rollover of a convertible, roadster or sport-utility vehicle, to project therethrough and clamp or jam the first shoulder belt portion **1.1**.

Upon plug-in connection of the latch plate **2** with the buckle assembly **4, 4a, 4b** the belt end ER of belt portion **1.1** is connected to the coupling fitting **1.2a, 1.2b** (**Figs.** 12~~1~~a, 12~~1~~b), whereto a number of energy absorbers is attached to absorb energy. In a cost-saving embodiment without the latch plate **2** and buckle assembly, the belt end ER of belt portion **1.1** is directly connected to the coupling fitting **1.2a** or **1.2b** (**Fig.** 18~~6~~) to receive energy absorbers, the retaining elements of which are fastened to the seat backrest frame **3.4d**. In order to absorb great energy and damp strong vibration ~~in the event~~ during in-flight turbulence~~-related vibrations of an aeroplane~~ or in the accident of a fast speeding car or high-speed train, the belt retractor **13**, coupling fitting **1.2b** of which is connected to energy absorbers, is moveable attached to the oblong holes of a stiff plate **13.3**, fastened to the seat-backrest frame ~~in~~ at the side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.

In the 1st ~~and 2nd~~ to 3rd embodiment (**Figs.** ~~12, 21~~11a to 11c) the buckle assembly **4a, 4b, 4c** is form- and/or force-locking connected to the seat-~~backrest~~ frame of the seat.

For the convenience of the passenger when egressing from the vehicle and in cases of emergency the following embodiments of detachment are proposed:

To disconnect the latch plates **2, 11** and/or **25** from the buckle assemblies **4, 14, 14a, 15, 15a** (**Fig.** 1) and pairs of supplement upper buckle assemblies **18 / 19, 18a / 19a, 18b / 19b, 18.1 / 19.1 to 18.3 / 19.3~~, 19, 19a, 19b, 19.1 to 19.3~~** (**Fig.** 23~~1~~5) of the seat arrangement, particularly for children, as well as from the anti-submarining buckle assemblies **7, 8, 8a to 8d** (**Figs.** 1, 14), the master release button **84**, when depressed, activates the release cables **4.2** and/or electrical release-motors **4.2b**, which pull the release button **84a** and/or **84b** of the buckle assemblies (**Figs.** 1~~1~~2a~~,~~ to 1~~1~~2b~~c, 21~~).

When depressing the master release button **84** the drive apparatus of the belt-feeding device **20, 20a~~, to 20d~~b** returns the first shoulder belt portion **1.1** from the ~~operating~~ operative position to the resting position.

~~According to the traffic- or flight law during the travel or turbulence-related flight passengers must remain belted. The need for a belted mother becomes apparent, when she~~

~~must take care of her frightened children seating on the rear seat. The separately operated release button **84o, 84d**, when depressed, detaches only the latch plates **11, 25** of the lap belt portion from the assemblies **7, 8, 8a, 8d** (**Figs.** 1, 23) to annul the protection from submarining.~~

~~In the 1st embodiment (**Figs.** 19 to 21) the height- and width-adjusting mechanism **27** comprises a frame **29**, buckle assembly **18.3, 19.3**, a pair of tubes **27.4**, members **27.5 to 27.9** and a pair of tubes **27.1** having a plurality of locking slots, in form- and force-locking connection with an angle fitting **26a**. The frame **29** consists of a pair of outer tubes **27.3**, a pair of tubes **27.2** and a connecting member of all tubes. The locking handle **27.5** is form- and force-locking connected to the slots of the inner tubes **27.4**.~~

~~These inner tubes **27.4**, inserted into the outer tubes **27.3**, are pre-loaded by the springs **27.6**. Each spring **27.6** on a sleeve **27.7**, secured by pin **27.8**, protruding through the holes of the inner tube **27.4**, presses against the spring rest **27.9** of the outer tube **27.3**.~~

~~The locking handle **27.5** is in engagement with a pair of locking slots of tubes **27.1**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of mechanism **27** and buckle assembly can be adjusted~~

~~The outer tube **27.3** is provided with a plurality of locking slots q, r, s etc., drawn with dotted lines in **Figs.** 20, 22.~~

~~After the pawl **18.10**, pre-loaded by the spring **18.5**, is detached from the locking slot r by its movement in the direction of arrow (**Fig.** 21), the housing **18.12**, form-locking connected to the buckle assembly **4c**, can be moved along both outer tubes **27.3**.~~

Belt-detachable U-shaped latch plates **25** offer the passengers a feature to adapt their body proportions to the appropriate ~~attachment points~~ pair of supplement upper buckle assemblies into which the latch plates **25** are inserted (**Figs.** ~~19~~ 15, ~~23~~17). Any belt portion, such as **1.1**, **1.2**, is loosely guided thereby, secured by a quick-release pin **25.1** thereof and detached therefrom by pulling the quick-release pin. To adapt a small body proportion of, say, a child, far lower than the upper buckle assembly **4** suited for adults, at least one pair of belt-detachable latch plates **25** are plug-in connected to one of the pairs of supplemental upper buckle assemblies **18 / 19, 1°a / 19a, 18b / 19b, 18.1 / 19.1 to 18.3 / 19.3**, arranged to the seat backrest at the first and second seat-side (**Figs.** 1 and 15). For safety reasons and easy access the belt-detachable latch plates **25**, when not being used, are stored and secured in a storage box **25.5** of the seat (**Fig.** 15).

~~For juxtaposed seats in vehicles, buses, trains and aeroplanes it is recommended to use a single locking handle **27.5** to operate the 2nd embodiment of the height- and width-adjusting mechanism **27a** of each seat **3c** having, for example, three pairs of openings **18.1 /19.1 to 18.3 / 19.3** to receive a pair of latch plates (**Figs.** 22, 23).~~

~~The frame **29a** consists of two pairs of outer tubes **27.3**, two pairs of tubes **27.2**, a pair of connecting members of all tubes and members **18.3, 19.3, 27.6 to 27.9a, 27.11**, attached to the outer tubes **27.3**.~~

~~The locking handle **27.5** is form- and force-locking connected to slots of the inner tubes **27.4** by the pins **27.12**. After inserting these inner tubes into the outer tubes **27.3** the locking plate **27.10** is form- and force-locking connected to the slots of the inner tubes and to the pins **27.12**.~~

~~After securing the spring rest **27.9a** by the retaining rings **27.11**, both sleeves **27.7a** by the pins **27.8**, protruding through the holes of inner tubes **27.4** and oblong holes of outer tubes **27.3**, the inner tubes with locking handle **27.5** are pre-loaded by springs **27.6**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of height- and width-adjusting mechanism **27a** can be adjusted.~~

Although the present invention has been described and illustrated in detail, it is clearly understood that the terminology used is intended to describe rather than limit. Many more objects, embodiments, features and variations of the present invention are possible in light of the above-mentioned teachings. Therefore, within the spirit and scope of the appended claims, the present invention may be practised otherwise than as specifically described and illustrated.